CHAPTER 3 - AFFECTED ENVIRONMENT

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This chapter describes the affected environment for the Proposed Action and Alternatives. The affected environment varies for each resource. For example, for most of the potentially affected resources, the affected environment is defined as the areas of proposed mine disturbance and the immediate vicinity (study area); however, for socioeconomic resources, the affected environment includes Caribou and Bear Lake Counties. The study area is defined in the section on each individual resource.

Of the 12 critical elements of the environment listed in the BLM NEPA Handbook (now 14 with the addition of noxious weeds and environmental justice), this EIS will discuss all but five. There are no areas of critical environmental concern within the area of influence of this project; there are no prime or unique farmlands in the area; and there are no wild and scenic rivers in the vicinity. The nearest wilderness area is more than 25 miles away and outside the area of influence of this project. The project area is in the headwaters of small streams, so floodplains are not an issue. Noise generation will not be discussed because there are no receptors within 2.5 miles. Noise effects on wildlife have been occurring on Rasmussen Ridge for approximately 20 years. It is assumed that wildlife have acclimated to the noise conditions. The list of critical elements to be discussed in this EIS includes air quality, noxious weeds, threatened and endangered species, solid and hazardous wastes, cultural resources, Native American traditional concerns, water quality, wetlands and riparian zones, and environmental justice. Other elements of the environment are also discussed in the following sections.

3.1 MINERALS, TOPOGRAPHY, GEOLOGY, AND PALEONTOLOGY

3.1.1 Mineral Resources

During the Permian Period, the Phosphoria Formation was deposited in a deep basin, at depths of several hundred feet over a large area of eastern Idaho, northern Utah, western Wyoming, and southwestern Montana (BLM and USFS 2002). The Phosphoria Formation forms the western phosphate field and comprises one of the world's largest known reserves of phosphate. The phosphate-bearing Meade Peak Member of the Phosphoria Formation is located on the east limb of the Snowdrift Anticline (**Figure 3.1-1**). The study area and general geology are shown in **Figure 3.1-2**.

The most important mineral commodity in the Rasmussen Ridge area is the phosphate rock of the Meade Peak Phosphatic Shale Member of the Phosphoria Formation. This rock is composed of carbonate fluorapatite minerals that occur as nodules, pisolites, oolites, pellets, and fossil fragments, along with organic matter and quartz, muscovite, and calcite as accessory minerals, and very small amounts of such metals as vanadium, uranium, chromium, nickel, and rare earths. Minor phases of numerous other minerals have also been identified in the deposit (Knudsen et al 2000).

Phosphate is a leasable mineral and one of a group of minerals named in the Mineral Leasing Act of 1920, as amended. Leasable minerals include oil, gas, geothermal, uranium, and coal. These minerals have widespread occurrence and purchasing a Federal or State lease gives an operator the right to mine these minerals. Leasable minerals are in contrast to locatable minerals for which a claim is staked after an ore body is found. Locatable minerals are those with intrinsic value and include base and precious metals and others with very specific chemical composition.

3.1.2 Topography Disturbance

The study area consists of a series of ridges and valleys (anticlines and synclines) with elevations ranging from 6,560 feet in Rasmussen Valley to 7,200 feet at Rasmussen Ridge. Henry's Peak, at an elevation of 8,319 feet, is about 2 miles north of the proposed North Rasmussen Ridge Mine site.

The existing total disturbance from mining within the Central and South Rasmussen Ridge Mine is 488 acres, which is located immediately southeast of the proposed North Rasmussen Ridge Mine. All of the waste rock generated for the proposed North Rasmussen Ridge Mine would be placed, as backfill, in the Central and North Rasmussen pits after the ultimate depths have been achieved. Changes in topography as a result of the South and Central operations include external waste rock dumps and the planned partial backfill of the last pit at Central Rasmussen.

3.1.3 Geology/Geologic Hazards

3.1.3.1 Geologic Setting

The Western Phosphate Field occurs within the Rocky Mountain Basin and Range physiographic province and extends across portions of eastern Idaho, western Wyoming, northern Utah and southwestern Montana. During the Permian and Triassic Periods, several thousand feet of marine limestone, chert, dolomite, shale and sediments accumulated in an interior sag basin located along the western margin of the North American Craton (Piper 1999). Economically important deposits of phosphate formed during Permian time that are contained within the Meade Peak Member of the Phosphoria Formation. Paleontologic evidence suggests that the phosphatic marine mudstones and shales of the Meade Peak Member were deposited at depths possibly as shallow as 600 feet (Yochelson 1968).

Rocks in the project area were folded and faulted during the Larimide Orogeny (late Cretaceous), which formed the predominant regional structural fabric of northwest trending anticlines and synclines. Northwest trending folds and faults in the project area are related to large-scale movement along the Bannock Overthrust that placed older western assemblage rocks over younger eastern assemblage rocks. The Bannock Overthrust is mapped at a depth of 3,000 to 4,000 feet below ground surface at Rasmussen Ridge and is not exposed in the project area (Mansfield 1927). Block faulting related to Basin and Range extension began about 17 million years ago and continues to the present.

Rocks that crop out within the study area range from Pennsylvanian to Permian in age. Stratigraphic units exposed at the surface include Alluvium, the Triassic-age Thaynes and

Figure 3.1-1 Regional Geologic Map

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Figure 3.1-2 Geology Map

Dinwoody Formations, the Permian-age Phosphoria Formation, and the Permian to Pennsylvanian-age Wells Formation. The Phosphoria Formation is divided into two members that include the Rex Chert and underlying Meade Peak Member. Locally, the Grandeur Member of the Park City Formation is also present above the Wells Formation, but the two units are mapped together because of the similarities in lithology (Maxim 2002a; Mansfield 1927). A partial generalized stratigraphic cross-section for the region is presented on **Figure 2.1-3**.

3.1.3.2 Stratigraphy

Paleozoic and Mesozoic rocks in the project area are overlain by alluvium and colluvium of Quaternary age. Unconsolidated deposits are present on slopes and in drainages in the project area and are composed of silt, sand, gravel, and clay. Drilling data indicate that the thickness of the alluvial cover varies from 20 to 65 feet in the area of the North Rasmussen Ridge pit. Alluvial thickness in drainages varies from 5 to 65 feet (Maxim 2002a).

The youngest rocks in the section are of the Thaynes Formation that outcrops northeast of the project area along West Sheep Creek. The Thaynes Formation is between 2,200 and 2,800 feet thick and can be divided into five members that include from top to bottom, the Portneuf Limestone, Nodular Siltstone, Black Shale, Platy Siltstone, and Black Limestone (Mansfield 1927; Ralston, Brooks, Cannon, Corbet, Jr., Singh, Winter, and Wai 1980). Studies by Robinette (1977) and Mohammad (1976) indicate that the Thaynes Formation is typically water bearing and may be part of an intermediate scale groundwater flow system in the Idaho phosphate region.

The Dinwoody Formation is present below the Thaynes Formation and has an approximate thickness of 900 feet. It is composed of interbedded limestone and siltstone with discontinuous shaley zones in the upper portion of the formation and calcareous shale and siltstone with thin limestone beds in the lower portion of the formation. The Dinwoody Formation outcrops northeast of the proposed North Rasmussen Ridge pit along the ridge between West Sheep Creek and No Name Creek. The Dinwoody Formation is water bearing in some locations and may be part of an intermediate scale groundwater flow system (Robinette 1977; Edwards 1977; Mohammad 1976).

The Phosphoria Formation is divided into two formally recognized members. The uppermost member is the Rex Chert that occurs stratigraphically below the Dinwoody Formation. The Rex Chert is 100 to 200 feet thick at Rasmussen Ridge and is composed of thick bedded to massive dark gray to blue-gray chert and cherty mudstone and limestone with interbedded gray to black shale. Locally, the Rex Chert is water bearing and forms part of a local groundwater flow system. The Meade Peak Member occurs below the Rex Chert and is the host of phosphate ore in the district. Rocks of the Meade Peak can be subdivided into five informal units that include the Hanging Wall Mud, the Upper Ore Zone, Center Waste Shale, the Lower Ore Zone and the Footwall Mud (Maxim 2002a; Petrun 1999; Piper 1999). The uppermost unit of the Meade Peak is the Hanging Wall Mud that varies in thickness from 10 to 15 feet and is composed of mudstone, siltstone, and cherty phosphorite. The upper ore zone occurs below the Hanging Wall Mud and is composed of about 15 to 16 feet of gray-brown to brown interbedded phosphatic mudstone, argillaceous phosphorite, oolitic phosphorite, and cherty mudstone. The Center Waste Shale occurs below the Upper Ore Zone and is composed of about 65 to 100 feet of dark gray to black mudstone, siltstone, argillaceous carbonate, and thin oolitic phosphorite interbeds. The Lower Ore Zone is about 40 to 45 feet thick and is composed of gray to brown interbedded oolitic phosphorite, phosphatic mudstone, siltstone and limestone, and argillaceous phosphorite. The Footwall Mud is the lower most unit of the Meade Peak and is composed of about 5 feet of massively bedded reddish brown siltstone with a thin layer of black fossiliferous phosphatic siltstone at the base. As a package, the predominantly fine-grained rocks of the Meade Peak Member have low permeability and act as a barrier to groundwater flow.

The Grandeur Tongue of the Park City Formation underlies the Phosphoria Formation and is mapped as part of the Wells Formation locally (Mansfield 1927). Rocks of the Grandeur Tongue are thick to massively bedded gray dolomite that is occasionally sandy or argillaceous and may be recrystallized in its upper portion. Locally the unit is 65 to 100 feet thick (Ralston et al 1980; Petrun 1999).

The Wells Formation underlies the Grandeur Tongue is divided into two members. The upper member is between 1,000 and 1,400 feet thick and is composed of buff colored sandy limestone, gray to reddish brown sandstone and interbedded gray limestone and dolomite (Ralston et al 1980). The lower member is 500 to 950 feet thick and consists of medium-bedded gray cherty limestone with some interbedded sandstone (Ralston et al 1980). In the area of the mine, the combined thickness of the Wells Formation (including the Grandeur Member of the Park City Formation) is mapped as being about 2,400 feet (Mansfield 1927). The Wells Formation is water bearing and is part of the regional aquifer (Ralston et al 1980).

3.1.3.3 Structural Setting

The proposed North Rasmussen Ridge Mine is located on the eastern limb of the Snowdrift Anticline that is situated on the upper plate of the Bannock Overthrust. Rocks in the project area dip 78 to 33 degrees east with the steeper dip being the predominant attitude of the rocks. The strike of bedding is approximately north 45 degrees west and is parallel to the axis of the anticline (Mansfield 1927).

Two northwest trending high-angle normal faults are mapped in the project area. The Enoch Valley Fault occurs along the southwestern limb of the Snowdrift Anticline and bounds the anticline in some locations (Mansfield 1927; Garrand 1974). The Limerock Fault is located northeast of the proposed pit and follows the drainage in Reese Canyon to the top of the watershed divide with West Sheep Creek (Mansfield 1927; Garrand 1974). Based on geologic interpretation by Mansfield (1927), the Enoch Valley and Limerock faults are continuous over distances of several miles (**Figure 3.1-1**).

Near the center of the proposed pit, the northern portion of the ore zone is displaced approximately 1,000 feet to the east by the Offset Fault. The Offset Fault strikes approximately east-west and is a high-angle normal fault dipping steeply to the north. The expansion plan for the North Rasmussen specifies that approximately 70 feet of the original ground that contains the Offset Fault would remain unmined between sections 16,300N and 16,400N.

3.1.3.4 Seismicity

The North Rasmussen Ridge study area lies within a Zone III seismic region that extends from northern Arizona through the Wasatch Front in Utah to the Yellowstone and Hebgen Lake regions in Wyoming and Montana. About 20 earthquakes capable of damaging structures (greater than 5.0 on the Richter Scale) have occurred within this seismic region from 1880 through 1994. The near-future earthquake activity would probably be similar to the past 100 years (BLM and USFS 2002).

3.1.4 Geochemistry

Selenium and other potential contaminants occur naturally in rocks associated with phosphatic ore in southern Idaho. Selenium has been identified as a constituent of special concern in the South East Idaho Phosphate District because of its potential to leach into groundwater and surface water and bioaccumulate in vegetation (Desborough et al 1999).

3.1.4.1 Occurrence and Environmental Mobility of Selenium and Metals in Overburden

Many metals and metalloids occur in elevated concentrations in the Paleozoic rocks of the region. Selenium (a metalloid) is the element of principal concern and occurs at concentrations above average crustal abundances in the Meade Peak Member of the Phosphoria Formation (Gulbrandsen 1960; Desborough et al 1999; Herring et al 1999). Selenium is an essential nutrient for the maintenance of health in mammals, but at high concentrations it can be toxic. Because of its potentially toxic effects and occurrence in waste rock from phosphate mines in southeastern Idaho, this EIS gives special consideration to mobility of selenium in the environment.

Geochemical studies of Permian-age rocks in southeastern Idaho indicate they generally contain less than 165 parts per million (ppm) selenium with the marine shales of the Meade Peak Member being the principal geologic reservoir (Gulbrandsen 1960; Desborough et al 1999). Selenium substitutes for sulfur in the lattices of sulfide minerals (Rapp 1972) and may be associated with sulfur in organic matter. Mineralogical studies by the U.S. Geological Survey (USGS) document the occurrence of seleniferous sphalerite, pyrite and organic compounds, as well as native selenium in rocks of the Meade Peak Member (Grauch et al 2001; Desborough et al 1999). Preliminary results of geochemical studies at the Rasmussen Ridge Mine also indicate that a significant portion of the total selenium content occurs outside of the identified mineralogical and organic reservoirs (Maxim 2001b). This finding suggests that selenium may also be present as surficial complexes adsorbed onto clay, carbonate minerals, and oxides of iron, aluminum, and manganese (Maxim 2002a).

The principal mineralogic reservoirs of selenium in the Meade Peak Member are the sulfide minerals sphalerite (ZnS) and pyrite (FeS_2) where selenide substitutes for sulfur in the crystal lattice. Native selenium has also been observed in rocks in the Idaho Phosphate District (BLM and USFS 2002). Reduced forms of selenium such as selenide and native selenium are relatively insoluble in water and have low environmental mobility. Exposure to the atmosphere, however, can oxidize selenide and native selenium into more mobile forms such as selenite and selenate.

Selenium that is released due to oxidation of the sulfide host minerals will also assume more mobile forms.

In general, selenium mobility increases with increasing oxidation state. Analysis of rocks from the Meade Peak Member sampled at Pole Creek indicates that only 2 percent of the total selenium content occurs as selenite which is mobile in water. Selenate and other highly mobile forms of selenium have not been observed in unweathered rocks in the region, but preliminary work by the USGS indicates that some rocks at Rasmussen Ridge are more weathered than most other locations in southeast Idaho (Maxim 2002a), yielding a very complex suite of secondary minerals.

In addition to selenium, overburden materials from Rasmussen Ridge contain elevated concentrations of other metals that could be mobile in the environment. Metals present at elevated levels in waste rock include aluminum, cadmium, antimony, manganese, nickel, and zinc (Gulbrandsen 1960, BLM and USFS 2002, Herring et al 1999; Desborough et al 1999; Maxim 2002a; Piper 1999). Concentrations of sulfate, fluoride, and total dissolved solids may also be increased in groundwater and surface water that receives runoff or infiltration from the waste rock.

Metal mobility in water is strongly influenced by pH, with most metals being more soluble and mobile under acidic conditions. At near-neutral pH, the solubility and mobility of most metals in the environment is low (Hem 1989). Increased mobility has been noted for some elements (notably selenium) under alkaline conditions at elevated pH (Desborough et al 1999; Munkers 2000).

3.1.4.2 Characterization of Overburden

Volume of Overburden

The study of environmental geochemistry prepared by Agrium (Maxim 2002a) focused on overburden and did not characterize the ore horizons that would be removed and shipped off site for processing, as they would not affect the environment at the mine site. The principal lithologies in the overburden at the proposed North Rasmussen Ridge Mine include Rex Chert, Hanging Wall Mud, Footwall Mud, Center Waste Shale, and limestone and dolomite of the Grandeur Member/Wells Formation (Maxim 2002a). A significant volume of alluvium would also be moved as overburden during mining operations, that would be used as growth media for reclamation. Volumes of overburden materials to be mined under the Proposed Action is summarized **Table 3.1-1**. Salvaged soils (some to 5 feet in depth) are not included in the totals in the table.

TABLE 3.1-1
OVERBURDEN VOLUMES AND PERCENTAGES

OVERBURDEN TYPE	VOLUME (BCY)	RUN-OF-MINE PERCENTAGE
Alluvium	8,655,770	16
Rex Chert	17,467,107	31
Hanging Wall Mud	3,079,634	6
Center Waste Shale	12,517,933	22
Footwall Mud	896,463	2
Wells Limestone	13,089,069	23
TOTAL	**55,705,976**	**100**

Note: BCY = Bank Cubic Yards

Geochemical Testing

The geochemical characterization program included sampling historical and active waste rock dumps at Rasmussen Ridge and testing of drill samples from the proposed mine expansion area (Maxim 2002a). Geochemical testing included acid-base accounting (ABA), analysis of selected metals content (aluminum, cadmium, iron, manganese, nickel, antimony, selenium, and zinc), paste extraction of pH and EC, and column leaching tests. An overview of the geochemical characterization program is summarized in **Tables 3.1-2**.

TABLE 3.1-2
SUMMARY OF GEOCHEMICAL TESTING FOR OVERBURDEN

		Number of Samples Tested						
Test Type	Sample Source	Alluvium	Rex Chert	Hanging Wall Mud	Center Waste Shale	Footwall Mud	Limestone	Total
ABA	Existing Waste Rock	1	4	2	17	5	3	**32**
	Proposed Waste Rock	20	20	20	20	20	20	**120**
Total Metals	Existing Waste Rock	1	4	2	17	5	3	**32**
	Proposed Waste Rock	20	20	20	20	19	20	**119**
Paste Extract	Existing Waste Rock	0	0	0	0	0	0	**0**
	Proposed Waste Rock	19	0	0	0	0	0	**19**
Column Testing	Existing Waste Rock	0	0	0	0	0	0	**0**
	Proposed Waste Rock	1	1	1	4	1	3	**11**

Acid rock drainage (ARD) can occur when sulfide minerals react with oxygen and water to produce sulfuric acid and other reaction products. Many metals become more soluble under acidic conditions and the formation of ARD can result in increased mobility of metals in groundwater and surface water. Acid produced by sulfide minerals can be neutralized by a number of reactions that involve carbonate minerals and basic silicates (Morin and Hutt 1994). The potential for ARD formation can also be minimized using appropriate engineering practices to reduce the availability of oxygen and water for the reaction.

ABA testing provides a theoretical estimate of the net acid-producing potential of waste rock by comparing the total acid forming potential to the neutralizing potential of the material. ABA tests do not consider the rates of acid formation or neutralization, which in many cases determine whether a material will produce acidic drainage. The ratio of acid neutralizing potential to acid generating potential (ANP/AGP) is typically used to evaluate data on ABA. Samples with ANP/AGP ratios greater than 3 are considered to have low potential to produce acid. ANP/AGP ratios between 3 and 1 are indeterminate, and ratios below 1 are potentially acid generating. The BLM risk threshold for acid rock drainage is based on an ANP/AGP ratio of 3 (BLM and USFS 2002).

A total of 152 ABA tests were conducted to evaluate the potential for production of ARD from overburden (Maxim 2002a). Samples submitted for ABA testing included 32 rock samples from historical and active waste rock dumps at Rasmussen Ridge and 120 samples from overburden in the proposed pit area. The average ANP/AGP ratio for run of mine overburden was calculated to be 23 for the combined historical and active waste rock dumps, and 17 for overburden samples from the proposed pit area. With the exception of center waste shale from existing waste rock dumps, the average values for ANP/AGP all exceed the threshold criterion of 3 and are considered non-acid generating. The average ANP/AGP value for historic center waste shale was calculated to be 2, which is indeterminate, but indicates that neutralizing potential is 2 times greater than acid-producing potential. The results of ABA testing agree with field observations of the weathering behavior of historic overburden materials and indicate that overburden from the mine is not expected to generate ARD. ABA results are summarized in **Table 3.1-3**.

The geochemical characterization program also included testing of 152 samples for total content of 50 elements (Maxim 2002a). Whole rock analysis of total elemental content was performed using a 75 percent aqua regia digestion with multi-element analysis by ICP-MS (inductively coupled plasma-mass spectroscopy). Elements analyzed for total concentration in waste rock samples are summarized in **Table 3.1-4**.

TABLE 3.1-3
AVERAGE ACID-BASE ACCOUNTING VALUES FOR OVERBURDEN

	Alluvium	Rex Chert	Hanging Wall Mud	Center Waste Shale	Footwall Mud	Limestone	Run of Mine
Historical and Active Overburden Dumps							
Number of Samples	1	4	2	17	5	3	--
ANP, T $CaCO_3$/kt	18	186	100	63	148	488	198
AGP, T $CaCO_3$/kt	1	4	3	31	9	0.33	9
ANP/AGP	18	53	40	2	16	1,464	23
Proposed Overburden							
Number of Samples	20	20	20	20	20	20	--
ANP, T $CaCO_3$/kt	53	53	131	139	399	798	257
AGP, T $CaCO_3$/kt	1	14	31	36	9	2	15
ANP/AGP	46	4	4	4	42	470	17

Notes: ANP = Acid-Neutralizing Potential
AGP = Acid-Generating Potential
T C_aCO_3/kt = Tons of calcium carbonate per 1,000 tons

Results of testing indicate that concentrations of cadmium, nickel, antimony, selenium, and zinc are elevated in overburden rocks above normal crustal abundances (Rose et al 1979) (**Table 3.1-5**). Cadmium concentrations are highest in Footwall Mud followed by limestone, Center Waste Shale, and Hanging Wall Mud. Nickel concentrations are highest in the Footwall Mud. Footwall Mud also has high concentrations of antimony and zinc. Selenium concentrations are highest in the Hanging Wall Mud, followed by the Center Waste Shale, Footwall Mud, and Rex Chert.

The geochemical characterization program also included 11 column leaching tests to evaluate the potential for release of metals in water that may contact overburden rocks (Maxim 2002a). Leaching tests were performed on columns containing a single rock type and used distilled water as the leaching agent. A total of 10 pore volumes of distilled water was passed through each column and then collected for analysis. Humidified air and occasionally dry air was circulated

TABLE 3.1-4
ELEMENTS ANALYZED FOR TOTAL CONCENTRATION IN WASTE ROCK SAMPLES

Silver	Cobalt	Potassium	Lead	Tellurium
Aluminum	Chromium	Lanthanum	Rubidium	Thorium
Arsenic	Cesium	Lithium	Rhenium	Titanium
Boron	Copper	Magnesium	Sulfur	Thallium
Barium	Iron	Manganese	Antimony	Uranium
Beryllium	Gallium	Molybdenum	Scandium	Vanadium
Bismuth	Germanium	Sodium	Selenium	Tungsten
Calcium	Hafnium	Niobium	Tin	Yttrium
Cadmium	Mercury	Nickel	Strontium	Zinc
Cerium	Indium	Phosphorous	Tantalum	Zirconium

TABLE 3.1-5
AVERAGE TOTAL CONTENT OF SELECTED METAL IN OVERBURDEN

	Number of Samples	Aluminum %	Cadmium ppm	Iron %	Manganese Ppm	Nickel ppm	Antimony ppm	Selenium ppm	Zinc ppm
Historic and Active Overburden Dumps									
Alluvium	1	0.87	29.40	1.35	180	94.0	0.85	3.6	970
Rex Chert	4	1.02	14.78	1.36	154	91.6	2.45	8.9	617
Hanging Wall Mud	2	1.99	25.46	2.53	3,850	426.3	3.43	10.4	2,857
Center Waste Shale	17	1.36	17.24	2.17	615	145.8	1.59	41.1	673
Footwall Mud	5	1.54	27.30	2.14	2,658	153.3	0.95	5.2	1,223
Limestone	3	0.74	23.75	0.92	287	127.7	0.98	1.1	1,075
Run of Mine Average	--	1.07	20.51	1.51	538	132.2	1.69	14	926
Average Crustal Abundance									
	--	8.1	0.1	4.7	1,000	75	0.1	0.1	80
Proposed Overburden									
Alluvium	20	1.85	4.88	2.51	2,625	75.4	1.47	6.5	280
Rex Chert	20	1.07	3.13	2.08	723	111.8	0.87	16.6	342
Hanging Wall Mud	20	1.40	22.89	1.60	179	155.0	1.70	76.0	559
Center Waste Shale	20	1.27	29.77	1.48	108	186.8	4.59	51.6	926
Footwall Mud	19	1.24	92.17	1.29	1,387	557.7	7.49	26.4	3,489
Limestone	20	0.28	43.24	0.64	643	184.6	1.96	4.1	1,736
Run of Mine Average	--	1.07	21.34	1.63	842	149.7	2.21	23	854

through the columns between pore volumes to promote oxidation and simulate weathering conditions. The distilled water was applied at a slow rate to prevent saturated conditions from forming. Sediment and water samples from existing waste rock dump seeps at the mine were analyzed for the presence of oxidizing bacteria to determine if the columns should be inoculated to stimulate oxiding conditions. The results of the analysis indicated that high concentrations of sulfide-reducing bacteria were present, but oxidizing bacteria were not (Maxim 2002a). Therefore, the columns were not inoculated.

Leachates from the columns were analyzed for 37 parameters. The analyses indicated that leachate concentrations generally decreased with increasing pore volumes. The pH of the column effluents were mostly above 7. The initial pH of the leachate from unweathered Center Waste Shale, however, was about 4.7 but increased to above 6 after the first pore volume. With the exception of the parameters listed in **Table 3.1-6**, all other analyses from the column test met Idaho groundwater standards. Results from the column tests also indicate that the predominant mobile form of selenium in solution is selenate (selenium^{+6}). Selenium is also present in leachates as selenite (selenium^{+4}), but typically, concentrations of selenite are an order of magnitude smaller than concentrations of selenate.

Geochemical characterization of alluvial materials also included 19 paste extraction tests. Alluvium in the project area is clay and organic rich with a paste pH between 5.7 and 7.8. Selenium concentrations in 14 of the 19 paste samples were below the detection limit of 0.01 mg/L. Average selenium concentrations in the remaining alluvium samples were 0.028 mg/L. Electrical conductivity of paste extracts ranged between 1.10 and 0.23 milliohms per centimeter (mmhos/cm). The low values for electrical conductivity and selenium in paste extracts indicate that alluvium has low potential to increase solute loads and release selenium in contact with water.

3.1.4.3 Conceptual Geochemical Model

Selenium and other constituents of concern occur naturally in overburden rocks associated with phosphatic ore. Leaching of these rocks when placed in waste rock dump facilities or used as backfill has the potential to release contaminants into receiving groundwater and surface water. Subsequent uptake of contaminated water by vegetation can affect other biological receptors. Agrium has been cooperating with state and federal regulatory agencies since 1996 to identify sources of contamination and to develop measures to mitigate impacts.

Several factors will affect leaching and mobilization of trace metals from overburden. These factors include increases in the reactive surface area of the rocks caused by mining, weathering of the material under atmospheric conditions, and the volume of runoff or infiltration in contact with the overburden. Under atmospheric weathering conditions, the relatively insoluble forms of selenium (selenium^{-2}), and (selenium^{0}) which make up the majority of selenium in overburden rocks are oxidized to selenite and selenate. Oxidation reactions can be bacterially mediated, and selenide (selenium^{+2}) (the most common form of selenium in unweathered shales of the Phosphoria Formation) can be oxidized directly to selenite without forming native selenium (selenium^{0}). Oxidizing bacteria, however, have not been identified in seeps and sediments associated with historical waste rock dumps at Rasmussen Ridge.

The principal reservoirs of selenium and other metals in overburden rocks include the lattices of sulfide minerals and as adsorbed complexes on clay and oxyhydroxides of iron, aluminum, and possibly manganese. Native selenium is also known to be present in overburden. Oxidation of sulfide minerals and infiltration or runoff of water through backfill can mobilize selenium and other metals.

TABLE 3.1-6
PARAMETERS THAT EXCEED GROUNDWATER STANDARDS IN COLUMN TEST LEACHATES

		Alluvium	Rex Chert	Hanging Wall Mud	Reduced Center Waste Shale	Weathered Center Waste Shale	Footwall Mud	Shallow Limestone	Deep Limestone	Idaho Groundwater Standards	
										MCL	SMCL
Sulfate	n_e/n_s Range, mg/L		7/7 623 – 2,700	7/7 440 – 2,180	11/14 165 – 2,240		1/7 52 – 855				250
TDS	n_e/n_s Range, mg/L	1/7 88 – 517	7/7 977 – 3,920	7/7 730 – 3,350	8/14 316 – 3,290		1/7 155 – 1,410	1/7 121 – 797			500
PH	n_e/n_s Range, su				8/14 4.7 – 7.4					6.5-8.5	
Fluoride	n_e/n_s Range, mg/L				11/14 3.61 – 7.16		1/7 1.09 – 4.14			4	
Aluminum	n_e/n_s Range, mg/L		3/7 <0.1 – 0.3	3/7 <0.1 – 0.2	11/14 <0.01 – 1.5	10/14 <0.1 – 0.4					0.2
Antimony	n_e/n_s Range, mg/L	1/7 0.004 – 0.006		6/7 0.005 –0.008	14/14 0.007 – 0.015	8/14 0.005 – 0.015	7/7 0.008 – 0.014	7/7 0.007 – 0.01	8/10 0.004 – 0.011	0.006	
Cadmium	n_e/n_s Range, mg/L		7/7 0.0067 – 0.0264	4/7 0.0038 – 0.239	13/14 0.0048 – 0.0747					0.005	
Manganese	n_e/n_s Range, mg/L	3/7 <0.015 – 1.13	7/7 2.59 – 10.1	7/7 0.534 – 2.75	14/14 0.307 – 6.32	3/7 <0.015 – 0.535	7/7 0.05 – 2.04	1/7 <0.015 – 0.88	4/10 <0.02 – 0.18		0.05
Nickel	n_e/n_s Range, mg/L		7/7 1.03 – 8.15	7/7 0.37 –1.66	11/14 0.05 – 170		1/7 <0.05 – 0.17			0.1	
Selenium	n_e/n_s Range, mg/L		7/7 0.21 – 0.860	7/7 1.23 –7.13	14/14 0.092 – 0.964	14/14 0.198 – 1.20	7/7 0.072 – 0.870	5/7 0.047 – 0.172		0.05	
Zinc	n_e/n_s Range, mg/L		5/7 0.31 – 10.2								5

Notes:
mg/L = milligrams per liter
SU = standard units
TDS = total dissolved solids
MCL = maximum contaminant level
SMCL = secondary maximum contaminant level
n_e/n_s = number of samples that exceed primary or secondary groundwater standards/number of samples analyzed

Selenite in solution is toxic; however, its mobility is hindered by its tendency to form relatively stable compounds with iron and aluminum (Herring et al 1999). Continued oxidation of selenite to selenate can increase the mobility of selenium in water. Selenate is less toxic than selenite, but is the most mobile inorganic form of selenium and is the form that is most easily accumulated by plants and animals. Vegetation may also bioaccumulate other metals if they are present in solution.

Column tests indicate that aluminum, antimony, cadmium, manganese, nickel, selenium, and to a lesser extent zinc are mobile in solution and can be expected to leach from overburden rocks. Concentrations of sulfate, total dissolved solids (TDS), and fluoride are also expected to increase in waters that contact overburden.

Other organic selenium compounds (such as amino acid selenomethionine) are common in the environment but have not been identified in unweathered rocks of the Phosphoria Formation. Organo-selenium compounds are commonly formed by reactions in plant tissue and become present in soil and water by decay of seleniferous vegetation (Herring et al 1999).

3.1.5 Paleontology

Sedimentary rocks in southeastern Idaho contain paleontological resources consisting of vertebrate, invertebrate, and paleobotanical fossils, including fish and shark remains. Fossils found in the North Rasmussen Ridge Mine area are not unique to the project area or southeastern Idaho. They are found throughout the region wherever similar formations exist (BLM and USFS 2002).

Fossils in the Wells Formation are described as predominantly consisting of bryozoa and brachiopods with wide distribution. The Meade Peak Member contains abundant pelecypods, gastropods, and brachiopods, as well as ammonites, nautiloids, crinoids, bryozoa, and sponge spicules. The base of the Meade Peak Member contains a thin marker bed identified as the fish scale bed, which contains some fossil fish and shark fragments. *Heliocoprion,* a fossil shark, has been found in the ore zones and other units in the Meade Peak Member. The Rex Chert Member contains brachiopods, crinoid fragments, and sponge spicules (BLM and USFS 2002).

Unconsolidated valley fill sediments in southeastern Idaho have yielded Ice Age and older mammals including mammoths, mastodons, horses, bison, camels, ground sloths, carnivores, rodents, and other animals. These fossils are from lake, stream, or windblown deposits and consist of clay, silt, ash, sand, and gravel (BLM and USFS 2002).

3.2 AIR RESOURCES

The study area for air resources consists of the immediate area near North Rasmussen Ridge Mine and the surrounding air shed within 100 kilometers. Standard environmental practices for evaluation of impacts to air resources require consideration of the airshed (generally the surrounding air shed within 100 kilometers) as well as to the immediate area. The North Rasmussen Ridge Mine is located in southeastern Idaho on Rasmussen Ridge between the Grays and Wooley mountain ranges. The nearest residence is over 2 miles away and the nearest sensitive area is Gray's Lake National Wildlife Refuge, which is over 10 miles to the north.

3.2.1 Climate

Major topographic features, such as the Wooley and Grays Ranges, influence the climate in the study area. Mountain ranges near the North Rasmussen Ridge Mine generally run northwest and southeast and affect local patterns of wind, precipitation, and temperature. The Blackfoot Reservoir is located about 9 miles west of the North Rasmussen Ridge Mine and may have some influence on the local climate. Valleys in the area range in elevation from about 4,500 feet to 8,300 feet. Rasmussen Ridge is at an elevation of about 7,000 feet.

The area experiences a wide annual and diurnal variation in temperature and humidity. The average annual precipitation is about 27 inches (Whetstone 2002). Normally, May is the wettest month, and July and August are the driest. Temperature extremes range from 83º F in July to 3.9º F in January. Frost or freezing conditions can be experienced in any month. The average wind velocity is 9 mph.

Data collected by the Western Regional Climate Center (WRCC), and the Natural Resources Conservation Service (NRCS) provide the general meteorological conditions in the study area. The WRCC operates weather stations at Conda, Pocatello, Soda Springs Airport, Henry, Idaho and Afton, Wyoming. The NRCS SNOTEL network monitors precipitation at Slug Creek Divide and Somsen Ranch. In addition, the Monsanto Corporation has operated a meteorological station in Enoch Valley since 1997. The location of each station, elevation, and distance from the North Rasmussen Ridge Mine area are summarized in **Table 3.2-1**.

The Enoch Valley meteorological station is located nearest to the North Rasmussen Ridge Mine (approximately 1.5 miles), however the station has a short period of record (4 years) and the data are not subjected to the same validation procedures used by the NWS and NRCS. The next closest meteorological station, the Somsen Ranch SNOTEL site, is located 4.1 miles from the mine on the northern flank of the Grays Range. The Somsen Ranch station is considered the most representative station for the North Rasmussen Ridge Mine, because it is near the mine and at approximately the same elevation (6,800 feet at the Somsen Ranch station vs. 6,905 feet at the mine shop). The next nearest meteorological station is the Henry station, located 5.5 miles east of the mine. The Henry station occurs at a lower elevation (6,140 feet) and the period of record is limited to 16 years (1971 to 1987) (Whetstone 2002).

TABLE 3.2-1
LIST OF METEOROLOGICAL STATIONS NEAR NORTH RASMUSSEN RIDGE MINE SITE

Station	Operator	Station ID	Period of Record Examined	Latitude	Longitude	Elev. (feet)	Distance From Mine (Miles)
Conda	WRCC	102071	8/2/1948 – 4/30/1978	42° 43’ N	111° 33’ W	6,200	14.4
Pocatello	WRCC	107211	1/3/1939 – 12/31/2001	42° 55’ N	112° 36’ W	4,447	60.5
Soda Springs Airport[1]	WRCC	108535	1978 – 2000	42° 39’ N	111° 35’ W	5,840	19
Afton, WY	WRCC	480027	5/1/1957 – 12/31/2001	42° 44’ N	110° 56’ W	6,210	26.6
Henry	WRCC	104230	9/23/1971 – 10/31/1987	42° 54’ N	111° 31’ W	6,140	5.5
Somsen Ranch	NRCS SNOTEL	S016	10/1982 – 12/2002	42° 57’ 00” N	111° 22’ 12” W	6,800	4.1
Slug Creek Divide	NRCS SNOTEL	S015	10/1982 – 12/2001	42° 34’ 12” N	111° 18’ 00” W	7,225	23.2
Enoch Valley	Monsanto	Enoch Valley	1997 – 2001	42° 52’ N	111° 25’ W	6,724	1.5

Source: WRCC 2002; NRCS 2002.

Table 3.2-2 shows average monthly temperature data for three monitoring locations reported by the WRCC. Average annual temperature ranges from 39°F in Henry, Idaho to 40.8 °F at Soda Springs, Idaho.

As shown in **Table 3.2-3**, precipitation records show a trend of lower precipitation at lower elevations. The mine site is at an elevation of approximately 7,000 feet. The heaviest precipitation occurs during the winter and spring months when snow and spring rains contribute to precipitation levels. Precipitation during the spring usually results from cool marine air flowing in from the south. Snow pack is influenced by the surrounding mountains and is greatest on the northeastern slopes. The least amount of precipitation occurs during the summer months. Summer precipitation is primarily associated with thunderstorm activities.

Intense heating by the sun during the daytime along with radiation cooling at night contributes to large fluctuations in diurnal temperatures. Summers are dry and winters are generally considered cold.

TABLE 3.2-2
MONTHLY AND ANNUAL TEMPERATURE DATA FOR STUDY AREA

Station	Elevation (feet)	Period of Record		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature (degrees F)																
Henry, Idaho	6,140	1971-1987	Max	27.1	34.4	40.8	52.0	61.5	72.2	80.4	79.4	69.5	56.4	39.9	30.9	53.7
			Min	3.9	7.6	14.5	22.8	33.1	39.9	43.6	41.9	34.4	26.0	15.6	7.6	24.2
			Mean	15.5	21.0	27.9	36.9	47.3	56.1	61.7	60.6	51.7	41.2	27.4	20.3	39.0
Conda, Idaho	6,200	1948-1978	Max	29.2	33.2	38.8	49.2	62.6	71.3	81.7	81.3	71.7	58.9	41.6	31.5	54.2
			Min	8.2	9.8	14.6	25.2	33.8	39.8	45.4	43.5	35.1	27.1	18.7	10.5	26.0
			Mean	18.9	21.5	26.8	37.2	48.1	55.6	63.7	62.4	53.4	43.2	30.1	21.0	40.1
Soda Spring Airport, Idaho	5,840	1978-2000	Max	30.2	32.7	41.7	53.8	63.3	73.5	83.0	82.4	71.9	58.8	41.1	30.8	55.3
			Min	8.6	10.6	18.9	26.2	34.2	39.7	44.3	44.0	35.7	26.3	18.2	7.9	26.2
			Mean	19.4	21.6	30.3	40.0	48.7	56.6	63.5	63.1	53.9	42.5	30.1	19.3	40.8

Source: Western Regional Climate Center 2002.

TABLE 3.2-3
AVERAGE MONTHLY PRECIPITATION (IN INCHES) AT NEARBY METEOROLOGICAL STATIONS

Station	Elev	Period of Record (years)	Dates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
Conda	6200	30	8/2/1948 – 4/30/1978	2.05	1.58	1.55	1.60	2.00	1.72	0.90	1.08	1.37	1.33	1.74	2	18.91
Conda	6200	29	1971-2000	2.25	1.97	2.06	1.74	1.86	1.41	1.21	1.42	1.47	1.7	1.82	2.26	21.17
Pocatello	4447	62	1/3/1939 - 12/31/2001	1.11	0.92	1.21	1.11	1.36	1.07	0.53	0.62	0.79	0.87	1.07	1.04	11.71
Afton	6210	37	5/1/1957 - 12/31/2001	1.47	1.29	1.29	1.66	2.08	1.79	1.25	1.24	1.52	1.4	1.48	1.43	17.89
Henry	6140	16	9/23/1971 - 10/31/1987	1.95	1.72	1.64	1.03	2.44	1.33	1.65	1.35	1.7	1.59	1.87	2.13	20.38
Slug Ck Divide	7225	19	Oct 1982 - Sept 2000	3.83	3.52	3.43	3.11	3.08	1.64	1.38	1.25	1.81	2.22	3.85	3.99	33.11
Somsen Ranch	6800	20	Oct 1982 - April 2002	1.81	3.20	3.13	3.19	2.65	2.54	2.43	2.72	1.47	1.23	1.14	1.29	26.88
Enoch Valley	6724	3	Jan 1997- Dec 1999	3.03	1.55	1.24	1.20	2.25	2.36	0.94	1.30	1.02	0.86	0.56	0.91	17.25

Source: NRCS 2002a; NRCS 2002b.

3.2.2 Air Quality

The federal government has established National Ambient Air Quality Standards (NAAQS) for criteria air pollutants. The criteria pollutants are carbon monoxide (CO), lead (Pb), sulfur dioxide (SO_2), particulate matter less the 10 microns in diameter (PM_{10}), ozone (O_3) and nitrogen dioxide (NO_2). The NAAQS are absolute allowable concentration limits for criteria air pollutants that apply to areas where the public has access. **Table 3.2-4** shows the NAAQS and State of Idaho Air Quality Standards.

The North Rasmussen Ridge Mine site is located within the portion of Air Quality Control Region 61, designated as an unclassified area. Air quality in the study area is therefore designated as unclassified for all pollutants. The unclassified designation means that existing concentrations of the criteria air pollutants are within the NAAQS.

Air quality in the study area is generally considered good. Current mining operations in the area include the Central Rasmussen Ridge Mine, Monsanto's (formerly Solutia) Enoch Valley Mine, and Monsanto's South Rasmussen Ridge Mine. The Central Rasmussen Ridge Mine is located south of the North Rasmussen Ridge Mine site, and the Enoch Valley Mine is located about one-half mile west. The nearest human dwelling is about 2 miles to the west.

Air quality monitoring data have been collected by the Idaho Division/Department of Environmental Quality at the Norton Site on State Highway 34 near Soda Springs, Idaho. Soda Springs is 19 miles southwest from the North Rasmussen Ridge Mine site. Data for PM_{10} have been collected at the site from 1989 through 2000. The annual average concentration has ranged from 20.1 to 38.3 micrograms per cubic meter ($\mu g/m^3$) during this time. The NAAQS for PM_{10} is 50 $\mu g/m^3$ and has not been exceeded during this time. The 24-hour maximum for PM_{10} (150 $\mu g/m^3$) was exceeded once in 1992 (**Table 3.2-5)**. It is assumed that concentrations of PM_{10} at the North Rasmussen Ridge Mine site are less than were measured in Soda Springs, given that Soda Springs is a relatively urban area in comparison to the mine area and because Soda Springs is 19 miles distant.

Data on the concentration of SO_2 have also been collected at two sites near Soda Springs, Idaho, from 1984 to 1990 and 1997 to 2000 and in Conda from 1982 to 1985 (**Table 3.2-6**). The annual average concentration of SO_2 in 1988 was 23 $\mu g/m^3$, well below the NAAQS of 80 $\mu g/m^3$. The 3-hour and 24-hour maximum concentrations recorded during this period were also well below the NAAQS. The SO_2 standards was not exceeded during these years.

TABLE 3.2-4
NATIONAL AMBIENT AIR QUALITY STANDARDS AND STATE OF IDAHO AIR QUALITY STANDARDS

Pollutant/ Averaging Time	State of Idaho and National Ambient Air Quality Standards (μg/m³)
Particulate matter (PM_{10}) 24-hour Annual	150 50
Carbon monoxide (CO) 1-hour 8-hour	40,000 10,000
Sulfur dioxide (SO_2) 3-hour (National) 24-hour Annual	1,300 365 80
Nitrogen dioxide (NO_2) Annual	100
Ozone (O_3) 1-hour	235
Lead (Pb) Quarterly	1.5

Note: μg/m³ = micrograms per cubic meter.
Source: 40 CFR Part 50.

TABLE 3.2-5
AMBIENT AIR QUALITY DATA FOR PM_{10} COLLECTED AT THE NORTON SITE SODA SPRINGS, IDAHO

Year	Annual Average (μg/m³)	24-Hour Maximum (μg/m³)	Number of Times Exceeded
2000	20.7	63	0
1999	24.2	90	0
1998	26.8	108	0
1997	21.1	63	0
1996	22.6	78	0
1995	20.1	73	0
1994	25.5	80	0
1993	24.7	55	0
1992	33.0	153	1
1991	24.3	59	0
1990	27.0	96	0
1989	38.3	74	0

Note: μg/m³ = micrograms per cubic meter.
Source: EPA, AIR*Data* 2002.

TABLE 3.2-6
MONITORING DATA FOR SO_2 COLLECTED IN SODA SPRINGS AND CONDA, IDAHO

Site	Year	1-Hour Maximum ($\mu g/m^3$)	Average 1-Hour Maximum ($\mu g/m^3$)	24-Hour Block Average ($\mu g/m^3$)	3-HOUR Block Average ($\mu g/m^3$)
#0003 Soda Springs High School Soda Springs, Idaho	1997	0.175	0.0033	0.028	0.119
	1998	0.147	0.0042	0.028	0.067
	1999	0.327	0.0041	0.055	0.160
	2000	0.196	0.0036	0.043	0.136
#0027 Conda Road 1.2 miles east of State Hwy 34 Soda Springs, Idaho	1984	0.321	0.0068	0.063	0.175
	1985	0.370	0.0102	0.099	0.242
	1986	0.182	0.0065	0.063	0.129
	1987	0.143	0.0051	0.023	0.056
	1988	0.493	0.0090	0.064	0.231
	1989	0.425	0.0093	0.097	0.268
	1990	0.249	0.0089	0.055	0.169
#0015 Conda Post Office Conda, Idaho	1982	0.410	0.0062	0.046	0.203
	1983	0.620	0.0081	0.093	0.373
	1984	0.940	0.0104	0.105	0.487
	1985	0.640	0.0157	0.188	0.440

Note: $\mu g/m^3$ = micrograms per cubic meter.
Source: EPA, AIR*Data* 2002.

3.3 WATER RESOURCES

The study area for water resources at the North Rasmussen Ridge Mine site consists of 20 square miles, as shown in **Figure 3.3-1**. The area encompasses the Grays Range to the north, the Wooley Range to the south, Enoch Valley on the west, and Upper Valley on the east. The primary focus of the investigation of water resources is the Rasmussen Ridge area, where the proposed mine expansion would be located. Water resources in the study area include surface streams, springs and seeps, shallow groundwater, and deep groundwater.

Three streams occur in the area of the proposed North Rasmussen Ridge Mine (**Figure 3.3-1**). These streams include the West Fork of Sheep Creek, which is tributary to Sheep Creek in the project area; No Name Creek; and the stream in Reese Canyon. Sheep Creek and its West Fork flow southeast and are tributary to Lanes Creek. Lanes Creek is tributary to the Blackfoot River. No Name Creek flows southeast and is tributary to Angus Creek. Angus Creek is tributary to the

Figure 3.3-1 Water Resources Study Area

Blackfoot River downstream of the confluence with Lanes Creek. The stream in Reese Canyon flows to the northwest and is tributary to the Little Blackfoot River.

Groundwater in the project area occurs in alluvium and bedrock and can be divided into three distinct flow systems: an upper shallow groundwater system occurs in alluvium: a shallow intermediate groundwater system occurs in the Rex Chert and Upper Meade Peak members of the Phosphoria Formation; and a deeper regional groundwater flow system occurs in the underlying Wells Formation. The intermediate groundwater system is typically under unconfined conditions and occurs at depths ranging from 100 to 170 feet. The regional groundwater system occurs at greater depths ranging from 300 to 500 feet near the mine.

Within the project area and surrounding region, shallow alluvial groundwater, localized flow systems, and surface water are interrelated. Streams and shallow groundwater may also provide limited seepage to the regional groundwater flow system.

3.3.1 Surface Water Resources

The project area is located within the Blackfoot River Subbasin, which encompasses an area of just over 1,000 square miles. Primary land use activities in the watershed include agriculture, livestock grazing, and phosphate mining. Waterbodies within the Blackfoot River Subbasin have historically sustained several beneficial uses. All streams support cold-water aquatic life and agricultural water supply as well as secondary-contact recreation, with the larger streams supporting primary-contact recreation. Most perennial streams have also maintained spawning populations of salmonids. Domestic water supply is also a designated use of the Blackfoot River above the reservoir.

Three streams occur within the study area. These streams include No Name Creek, Reese Canyon Creek, and Sheep Creek. A drainage divide occurs in the northwestern portion of the project area that separates surface water tributary to the Little Blackfoot River from water tributary to the Blackfoot River. Reese Canyon Creek flows to the northwest and is tributary to the Little Blackfoot River. No Name Creek and Sheep Creek flow southeast to Angus Creek and Lanes Creek, which are tributary to the Blackfoot River (**Figure 3.3-1**). The Little Blackfoot River and the Blackfoot River both discharge into the Blackfoot Reservoir.

Streamflow regimes in the project area are regulated by periods of snowmelt, direct precipitation, surface runoff, and groundwater discharge from seeps and springs. Beaver dams in the low gradient reaches of Sheep Creek and Reese Canyon provide additional flow alteration and some water retention during periods of low flow. Stream gradients in the vicinity of the project area are generally low with high potential for flooding in spring and early summer. Base or low flows occur during the winter.

No streams within the project area are designated as Outstanding Resource Waters or as Special Resource Waters according to Idaho Administrative Procedures Act (IDAPA) 58.01.02. Likewise, no streams are designated under the Wild and Scenic River System or listed in the Nationwide Rivers Inventory as having "outstandingly remarkable values" that could make them eligible for inclusion in the system (National Park Service 2003).

Sheep Creek, Angus Creek, Lanes Creek, and the Blackfoot River below the confluence with Lanes Creek are listed as water quality limited waterbodies under Section 303(d) of the Clean Water Act (CWA) (IDEQ 2001). Sheep Creek occurs within the project area and is tributary to Lanes Creek, which is tributary to the Blackfoot River. Angus Creek is within the cumulative effects area and receives water from No Name Creek before it discharges into the Blackfoot River below Lanes Creek. Section 303(d) of the CWA requires states to identify waterbodies that do not meet water quality standards for the designated beneficial use. Designated beneficial uses for streams in the project area and the cumulative effects area are summarized in Table 3.3-1. In addition, states are required to establish Total Maximum Daily Loads (TMDLs) for pollutants to meet water quality standards for the designated use.

TABLE 3.3-1
DESIGNATED BENEFICIAL USES AND 303(D) LISTINGS FOR STREAMS IN THE CUMULATIVE EFFECTS AREA

Waterbody	303(d) Listed Segment		303(d) Listed Pollutants	Designated Beneficial Uses									
	Lower	Upper		Cold Water Biota	Warm Water Biota	Salmonid Spawning	Primary Recreation	Secondary Recreation	Domestic	Agricultural	Industrial	Wildlife Habitat	Aesthetics
Angus Creek	Blackfoot River	Headwaters	Sediment	Y		Y	Y			Y	Y	Y	Y
Blackfoot River	Blackfoot Reservoir	Headwaters	Sediment Nutrients	Y		Y	Y	Y	Y	Y	Y	Y	Y
Lanes Creek	Blackfoot River	Headwater	Sediment	Y		Y					Y	Y	Y
Little Blackfoot River	None	None	None										
No Name Creek	None	None	None										
Reese Canyon Creek	None	None	None										
Sheep Creek	Lanes Creek	Headwater	Sediment	Y		Y				Y	Y	Y	Y

Sources: IDAPA 58.01.02 and Blackfoot River TMDL Waterbody Assessment and Total Maximum Daily Load (IDEQ 2001)

No Name Creek

No Name Creek is a small, intermittent stream that flows south through a narrow fault block canyon and enters Angus Creek west of Rasmussen Ridge, above its confluence with the Blackfoot River. The flow in No Name Creek is charged primarily by precipitation and snowmelt. No Name Creek originates near the headwaters of Sheep Creek east of the existing mine and drains the immediate area of the mine. No Name Creek is an undesignated surface water body and, as such, cold water aquatic life and primary or secondary contact recreation criteria apply (IDAPA 58.01.02.101.01.a).

Flow in the West Fork of No Name Creek is currently diverted through a channel to provide continuous drainage during existing mine operations. The main stem of No Name Creek is not affected by this diversion. Overall, the No Name Creek drainage appear to lose flow; although there is evidence for minor discharge related to seeps and springs in the upper reaches (Maxim 2001a).

Upstream of the Central Rasmussen Mine, C3/C4 channel types are prevalent (channel descriptions and definitions are presented in **Table 3.3-2**). Stream gradients are relatively shallow, about 3 percent, and stream widths range between 3 and 6 feet. Below the mine, channels in No Name Creek can be generally characterized as A3/A4. The floodplain broadens as the stream exits the canyon, and B3 channel types are evident (Maxim 2001a). E4 channel types predominate above the confluence with Angus Creek.

Sheep Creek

Sheep Creek is an intermittent stream in its upper reaches, and perennial in its lower reaches, with flows maintained by springs and seeps and augmented with precipitation and snowmelt. Designated beneficial uses include cold water biota, salmonid spawning, agricultural and industrial water supply, wildlife habitat, and aesthetics. From its confluence with Lanes Creek to its headwaters, Sheep Creek is a 303(d) water quality limited stream listed for sediment. Beneficial uses affected are cold water aquatic life and salmonid spawning, with livestock grazing a likely source of pollutants (IDEQ 2001).

Sheep Creek meanders through the length of the drainage and flows southeasterly to its confluence with Lanes Creek. Numerous small beaver dams are located throughout the drainage, as well as short stretches of riffles, runs, and pools. Tributaries that drain the upland areas of Sheep Creek are confined or incised drainages, with some having perennial flow. Generally, streams within the Sheep Creek drainage appear to be gaining flow, although sediment traps and beaver dams alter flow locally (Maxim 2001a).

The upper portion of the West Fork of Sheep Creek is predominantly C4 channel type. Stream gradient is about 2 percent. The lower portion of the West Fork of Sheep Creek is characterized by B3/B4 channel types. Stream gradient is about 4 percent, and the channel is narrow and incised. The main stem of Sheep Creek is predominantly B4 channel type at the headwaters, with stream gradient of about 3 percent and channels widths from 3 to 6 feet. The lower reaches of the main stem exist within a broad, unconfined valley characterized by E4 channel types (Maxim 2001a). Stream gradient is lower, about 2 to 3 percent, and channels are much wider, about 10 to 20 feet.

Reese Canyon Creek

Reese Canyon Creek is an intermittent stream that flows northwesterly 1.8 miles to its confluence with the Little Blackfoot River. Reese Canyon Creek is an undesignated surface water body and, as such, cold water aquatic life and primary or secondary contact recreation criteria apply (IDAPA 58.01.02.101.01.a).

TABLE 3.3-2
CHANNEL DESCRIPTIONS

Stream Type	General Description	Entrenchment Ratio	W/D Ratio	Sinuosity	Slope	Landform/ Soils/Features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.	<1.4	< 12	1.0 to 1.1	> .10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	< 1.4	< 12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	> 12	> 1.2	0.2 to 0.39	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and width/depth ratio. Narrow, gently sloping valleys. Rapids predominate w/scour pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains.	> 2.2	> 12	> 1.4	< 0.2	Broad valleys w/terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	> 40	n/a	< 0.4	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment, w/abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and W/D ratios. Very stable streambanks.	> 2.2	Highly variable	Highly variable	< .005	Broad, low-gradient valleys with fine alluvium and/or lacrustine soils. Anastomosed (multiple channel) geologic control creating fine deposition w/well-vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash load sediment.

TABLE 3.3-2 (CONT.)
CHANNEL DESCRIPTIONS

E	Low gradient, meandering riffle/pool stream with low W/D ratio and little deposition. Very efficient and stable. High meander/width ratio.	> 2.2	< 12	> 1.4	< .02	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low W/D ratios.
F	Entrenched meandering riffle/pool channel on low gradients with high W/D ratio.	< 1.4	> 12	> 1.4	< 0.2	Entrenched in highly weathered material. Gentle gradients, with a high width/depth ratio. Meandering, laterally unstable with high bank erosion rates.
G	Entrenched "gully" step/pool and low W/D ratio on moderate gradients.	< 1.4	< 12	> 1.2	.02 to .039	Gullies, step/pool morphology w/moderate slopes and low W/D ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials, i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

Notes: C3: C stream type with 3 substrate class.
Substrates = 1 - bedrock, 2 - boulder, 3 - cobble, 4 - gravel, 5 - sand, 6 - silt/clay
Source: Rosgen 1996.

Stream gradients in channels in Reese Canyon Creek range from 10 percent and up in the headwaters, to 3 to 5 percent near the confluence with the Little Blackfoot River (Maxim 2001a). Reese Canyon Creek is a confined system with no major tributaries. The channel follows the high-gradient, confined walls of Reese Canyon. Flow is fed by several perennial seeps and small springs along its length. The channel is dry in most reaches by late summer. Overall, Reese Canyon Creek appears to be gaining flow, though groundwater influence and beaver dams alter flow locally (Maxim 2001a).

The channels in the upper reaches of Reese Canyon are characterized as A4 stream types because of the higher stream gradient, whereas the middle reaches are C4 stream types. The lower reaches of Reese Canyon are also best characterized by C4 stream types, although the gradients are slightly steeper than are typical of C4 stream types and are more entrenched (Maxim 2001a).

Lanes Creek

Lanes Creek is a perennial stream located 5 miles southeast the project area that receives flow from Sheep Creek. Below its confluence with Sheep Creek, Lanes Creek meanders south about 0.8 miles, where it becomes the headwater of the Blackfoot River. Designated beneficial uses of Lanes Creek include cold water biota, salmonid spawning, industrial water supply, wildlife habitat, and aesthetics.

Lanes Creek is a 303(d) water quality limited stream listed for sediment. Beneficial uses affected are cold water aquatic life and salmonid spawning, with livestock grazing a likely pollutant source (IDEQ 2001).

Angus Creek

Angus Creek is a perennial stream located 2 miles south of the project area that receives water from No Name Creek and drains Rasmussen Valley. Below its confluence with No Name Creek, Angus Creek flows southeast 2.7 miles to its confluence with the Blackfoot River. Designated beneficial uses of Angus Creek include cold water biota, salmonid spawning, secondary contact recreation, agricultural and industrial water supply, wildlife habitat, and aesthetics.

Angus Creek is a 303(d) water quality limited stream listed for sediment. Beneficial uses affected are cold water aquatic life and salmonid spawning, with livestock grazing a likely pollutant source (IDEQ 2001).

Little Blackfoot River

The Little Blackfoot River is a perennial stream located 1.5 miles northwest of the project area that receives water from Reese Canyon Creek. Below its confluence with Reese Canyon Creek, the Little Blackfoot River flows southwest 5 miles, where it discharges into the Blackfoot Reservoir. The Little Blackfoot River is a undesignated surface water body and, as such, criteria for cold water aquatic life and primary or secondary contact recreation apply (IDAPA 58.01.02.101.01.a).

Blackfoot River

Blackfoot Reservoir impounds the Blackfoot River downstream from the project area. Principal streams in the Blackfoot River basin include Lanes Creek, Diamond Creek, Angus Creek, Dry Valley Creek, Slug Creek, and Trail Creek. The Little Blackfoot River enters the Blackfoot Reservoir at Henry, Idaho, 8 miles downstream of the confluence with Reese Canyon.

There are no permanent stream gauging stations located in the project area. Data on mean annual flow from gauging stations downstream have been compiled to represent regional perennial flow downstream of the project area. These data are summarized in **Table 3.3-3**. Streamflow hydrographs are presented in **Figure 3.3-2a** and **b**.

TABLE 3.3-3
ANNUAL STREAM FLOW STATISTICS IN THE BLACKFOOT RIVER BASIN

Station	Station Description	Period of Record	Mean (cfs)	Min (cfs)	Max (cfs)
13062700	Angus Creek above No Name Creek	1962-1981	n/a	n/a	1,060
13063500	Little Blackfoot River at Henry, ID	1914-1925	19	4.3	292
13063000	Blackfoot River above reservoir near Henry, ID	1915-1926; 1968-1982 2001-2002	186.6	20.5	2,150

Notes: cfs = cubic feet per second
n/a = not available
Source: USGS 2002.

Figure 3.3-2a Hydrographs for No Name, Sheep and Reese Canyon Creeks

Figure 3.3-2b Hydrograph for Blackfoot River